Observations on the breeding biology and behaviour of the long-necked tortoise, *Chelodina oblonga*

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Abstract

Chelodina oblonga, a common tortoise in the fresh waters of the south-western coastal belt of Western Australia, has two nesting periods: one in spring (September to November), and one in summer (December to January). Cool conditions with rain occur during the spring period, and hot dry conditions prevail during the summer period. Specific weather conditions were associated with the nesting periods including the occurrence of seasonal rain-bearing low pressure systems, a falling barometric pressure, and an air temperature above 17°C. Distances travelled by the gravid female to the nesting site were variable and were generally greater during the spring period. Animals were active within a body temperature of 18°C to 31°C and dehydrated quickly with air temperatures in excess of 25°C. Difference in clutch sizes were apparent between nesting periods, and egg weights, egg sizes and clutch sizes varied between individuals. The incubation period was almost identical for each nesting period, ranging from 210 days to 222 days. Hatchlings from both nesting periods emerged at the same time in mid-August.

Introduction

The family Chelidae is represented in Western Australia by six species of fresh-water tortoise. *Chelodina rugosa* is found only in the Kimberley and *C. steindachneri* is found in the arid zone within the river systems from the Irwin River south of Geraldton to the De Grey River in the Pilbara. The short-necked tortoises are represented by *Emydura australis* and *Elseya dentata* in the Kimberley, and *Pseudemydura umbrina* which occupies an area of a few square kilometres just north-east of Perth. The common long-necked tortoise, *Chelodina oblonga,* is found in the south-west of Western Australia (Cogger 1975).

Although *C. oblonga* is common in the south-west of Western Australia there is little literature available concerning its behaviour in the field. Burbidge (1967) investigated the biology of *Pseudemydura umbrina* and *Chelodina oblonga.* Nicholson (1974 pers. comm.) described the nesting behaviour of *C. oblonga.*

The aim of this paper is to report on the movements and breeding behaviour of a wild population of *C. oblonga.* Over a period of four years climatic and seasonal factors which are associated with movement and reproductive biology have been measured and an attempt was made to assess those environmental variables which affect breeding.

Study area

Thompson Lake Nature Reserve No. 15556, vested in the Western Australian Wildlife Authority and managed by the Department of Fisheries & Wildlife, and the Marsupial Breeding Station, No. 29241

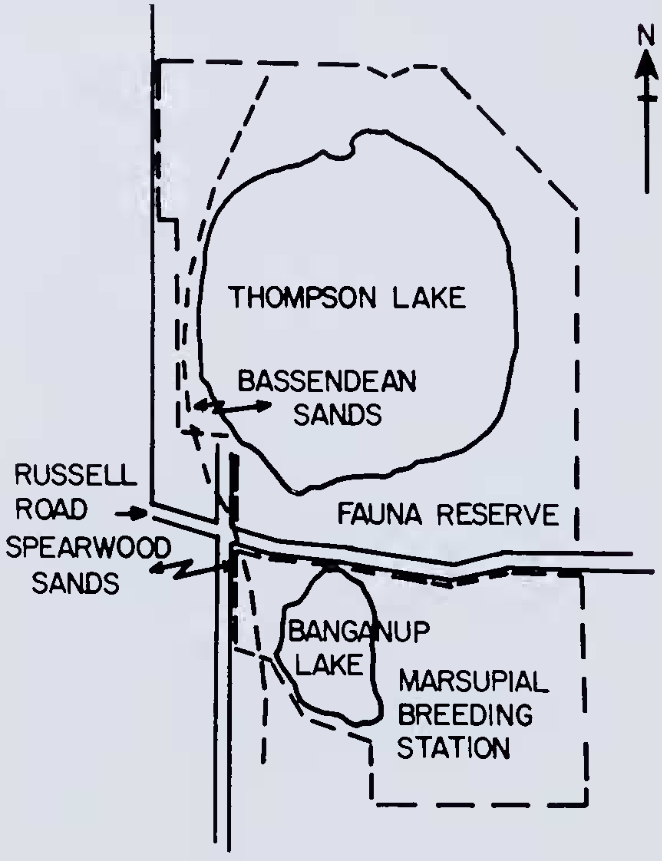

Figure 1.—Map showing study areas and boundary between the Bassendean-Spearwood Sands; scale: 1:25 000.

managed by the University of Western Australia and vested in the Minister for Fisheries and Wildlife are both situated in the City of Cockburn. These study areas lie approximately 25 km south of Perth, Western Australia at latitude 32° 10′ S, longitude 115° 50′ E. The total area of Thompson Lake Reserve is 509 ha with the lake occupying 172 ha. The area of the Marsupial Breeding Station is 253.7 ha with Banganup Lake occupying 32 ha (Fig. 1).

The two reserves lie mostly within the Bassendean Sand complex with the Spearwood Sands bordering Thompson and Banganup Lakes on their west side (Seddon 1972). The boundary between the two sands is shown in Figure 1.

The vegetation of the higher well-drained Bassendean Sands consists mainly of Jarrah *(Eucalyptus marginata)* and *Banksia* spp. The vegetation on the higher Spearwood Sands consists mainly of *Banksia* spp, Jarrah and Tuart *(Eucalyptus gomphocephala)*. The lower areas close to the lakes are dominated by the Swamp Gum *(E. rudis)*, paperbarks *(Melaleuca* spp.) and the jointed rush *Baumea articulata* in varied associations with other reeds and rushes.

Methods and materials

Capture

Animals moving to nest were captured on the boundary fence surrounding the Marsupial Breeding Station. Females in the Thompson Lake Reserve were captured as they moved to nest and other females were followed to the nest site. Animals were also captured in simple wire mesh fish type traps using liver as bait.

Marking and measurement

Where possible adults were weighed on a Salter spring balance, weighing to the nearest gm. Carapace and plastron widths and lengths, body depths and tail lengths were measured, the last from the tip of the tail to the middle of the concave section of the plastron with linear calipers. Stainless steel tags were inserted in two holes drilled on the edge at the rear of the carapace. Because the metal tag disintegrates, the same number was also branded on the middle of the plastron using a cauterizer. The presence of eggs was determined by pushing the index finger against the abdominal cavity.

Distances from the water's edge to the nest site were measured during the two nesting periods. Nest sites were located by regular and systematic searching of the study areas. Some nest sites were left undisturbed, marked with a wooden stake and labelled. Each nest site was surrounded with wire mesh and fly wire attached to the lower half to prevent hatchlings from escaping. Other nest sites were excavated and measured, and the eggs removed for other experiments. Eggs were measured with linear calipers and weighed on a Mettler P 1200 balance.

Artificial nest sites similar to the original sites were selected and egg chambers dug by hand. Times from nesting to the emergence were recorded. Other eggs were placed in glass-fronted nest chambers to observe hatching and emergence dates.

Body, water and nest temperatures were recorded with a YSI model 44 telethermometer.

Weather

Rainfall figures were monitored daily at the Marsupial Breeding Station throughout the study period. High and low pressure systems were followed by studying the daily weather charts published by the Western Australian Bureau of Meteorology. Temperature and relative humidity were recorded continuously on a Thiess hygrothermograph maintained in a Stevenson Screen.

Results

Mating

Although intensive observations were made daily throughout the nesting periods, *C. oblonga* were never observed copulating on land or in the water.

Sex determination

Gravid females were easily sexed. Post mortems were carried out to determine the sex of non-gravid females and suspected males and from these data all tortoises were sexed from the ratio of the tail length to the body depth. Females have a ratio of less than 1.0 : 1 and the males a ratio greater than 1.4 : 1 (Fig. 2). The difference between females and males is highly significant ($p<.001$).

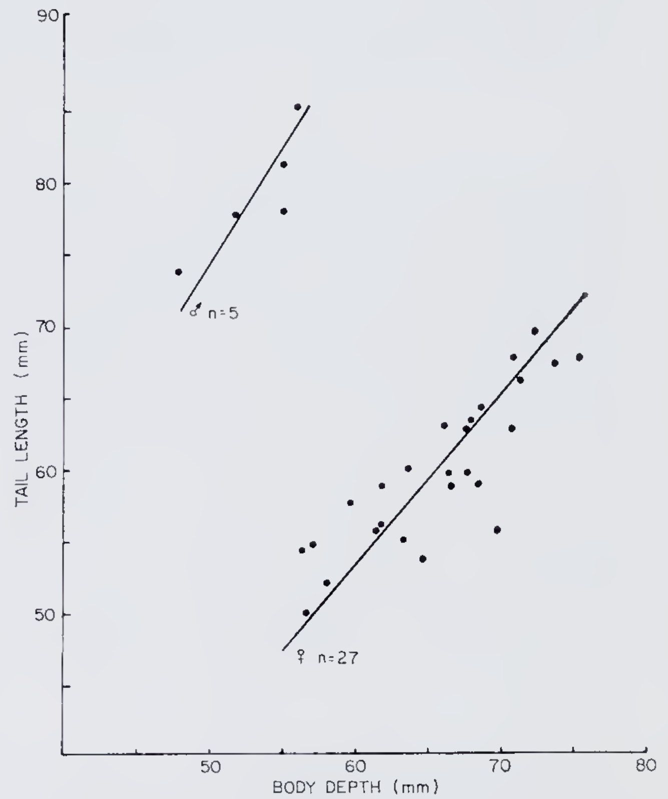

Figure 2.—Ratio of tail length to body depth of male and female *Chelodina oblonga* is highly significant ($.01<P<.001$).

Nesting periods

Weather.—In south-western Australia the highest rainfall occurs during the winter months (Western Australian Year Book 1973). From observations during this study tortoises moved to nest for the laying of the first clutch of eggs at the end of winter. The earliest movement was recorded on 9 September 1974 and the latest movement was recorded at the beginning of November 1976. The second nesting period did not correlate with any observed weather pattern.

Stimulus for movement.—During this study the lowest recorded body temperature was 18°C with an air temperature of 16.2°C at the time of capture. The highest recorded body temperature was 31.0°C with an air temperature of 27.0°C at time of capture (Fig. 3). Once the maximum daily temperature remains above 17.5°C the females move to nest (Fig. 4). Mean daily maximum temperature on days of movement during the summer period are higher than those during the spring period (Table 1).

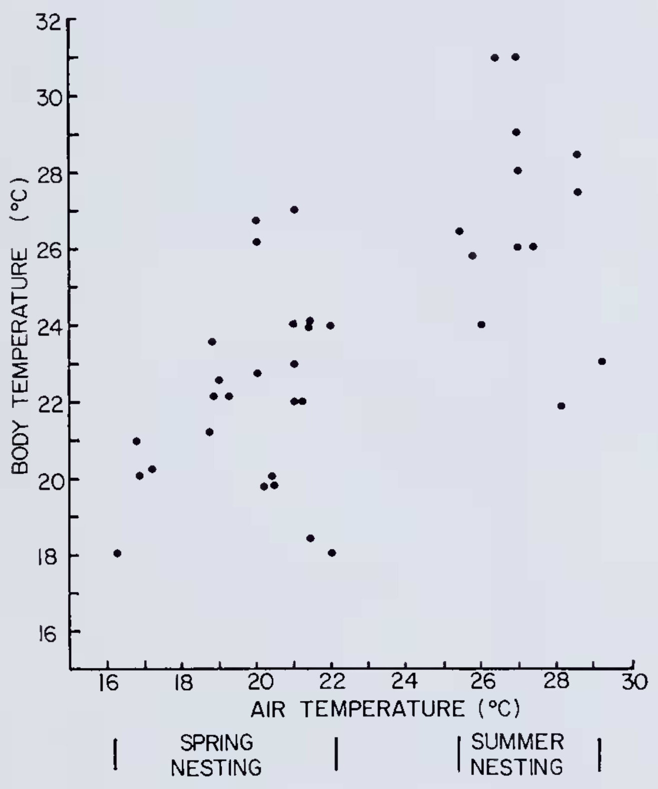

Figure 3.—Body and air temperatures at time of capture of gravid females moving to nest during the spring and summer nesting periods.

Weather patterns during the spring period characteristically approach from the south-west, and associated low pressure systems are normally rain-bearing depressions. Records during this study indicate that the females move to nest as the barometric pressure decreases (Fig. 5). A strong relationship between animal movement and the approach of a rain-bearing depression is evident. Barometric patterns typical of those correlated with movements of females are shown in Figure 5. Once the spring nesting period has commenced, future spring nesting periods may be predicted by observation of the weather patterns. There is no relationship between the weather pattern and the movement of the second nesting.

Movement.—During this study most animals captured were females moving to nest. The 1975/1976 data show that of the 76 animals captured, 67 were females and 9 were males. Of the 67 females

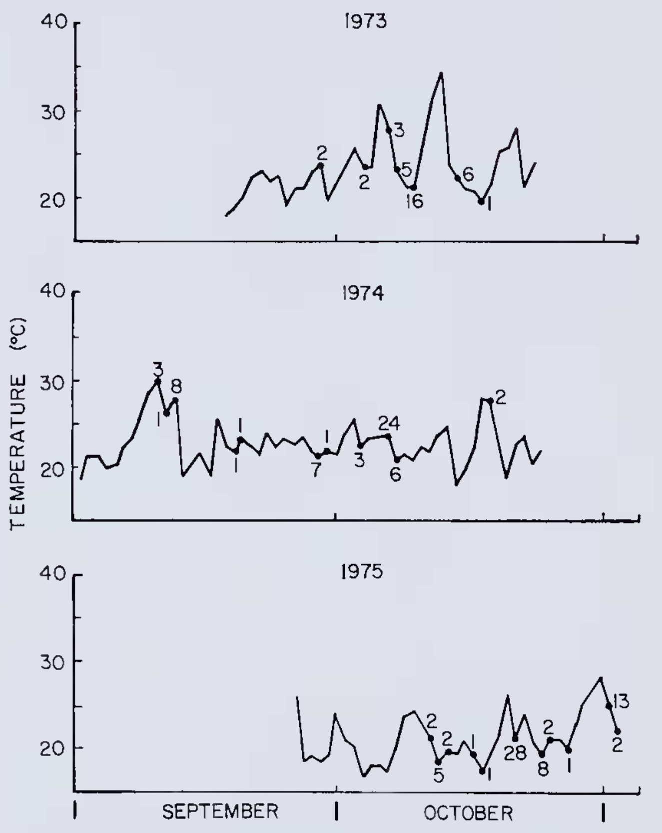

Figure 4.—Females moving to nest after daily maximum temperatures remain above 17.5°C and showing numbers with daily maximum temperatures.

Table 1

Mean daily maximum temperature (°C) recorded on day of movement

Movement	Mean daily maximum temperature on day of movement	Number of days on which movements were observed
Sept./Nov.		
1973	24·0	7
1974	23·5	13
1975	20·6	11
Dec./Jan.		
1973/74	32·1	11
1974/75	25·9	3
1975/76	26·7	6

captured 12 animals were without eggs and it was presumed that these had already laid eggs (Table 2). It is evident that females move to nest during both September/November and December/January. Males appear to move both prior to and after the main nesting periods (Table 2).

There was no evidence to show that females migrate except where the natural environment is drying up. Females during this study appeared to move only to nest. Males captured appeared to be migrating from one lake to the next.

Nesting and nest site

Approach to shore.—*C. oblonga* approached the shore very cautiously. Remaining in shallow water with the head held well above the water line and

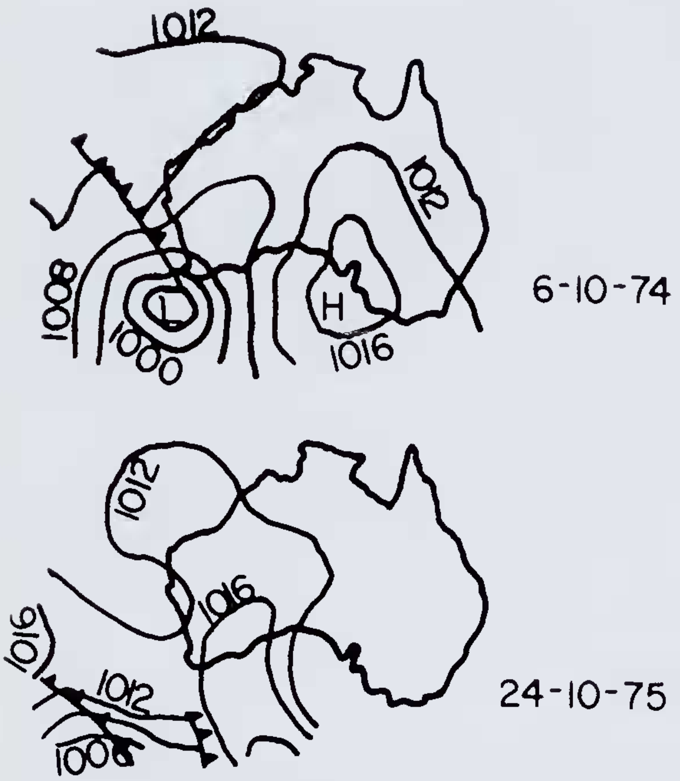

Figure 5.—Isobars recorded by the Weather Bureau at 1500 h indicating approaching cold fronts. 24 gravid females were captured moving to nest on the 6/10/74 whereas no animals were captured on the 24/10/75. 15 gravid females were captured 25th-26th as the depression with falling pressure moved over the coast.

Table 2

Male and female movement during the periods (a) 1975/1976 and (b) 1976/1977

(a)

Date	Female	Male
Sept. 1975	0	2
Oct. 1975	62	2
Nov. 1975	3	2
Jan. 1976....	2	2
Feb. 1976	0	1
	*67	9

* 12 females without eggs.

(b)

Date	Female	Male
Sept. 1976	1	1
Oct. 1976	1	5
Nov. 1976	13	1
Dec. 1976	1	0
Jan. 1977....	4	0
	20	7

at the same time resting on the lake bed, animals would take varying lengths of time before emerging. At this stage they were easily disturbed and would retreat to deeper water. As observed by Hendrickson (1958) *Chelonia mydas* approaches the shore in the same way.

Order of events during nesting.—Typical nesting behaviour of *C. oblonga* taken from field note book dated 6 October 1974:

0945 h Proceeded to study area at Thompson Lake. A rain-bearing low depression forecast. Air temperature 22°C with a light south-westerly wind and 8/10 cloud cover.

0955 h Observed female tortoise leaving the water. During the first 40 m the tortoise did not deviate from its original course, in a south-westerly direction. Once it gained the protection of the vegetation it used all available cover.

1050 h Started to move in a southerly direction.

1112 h Selected nest site. The site was open and comparatively flat with little vegetation except for native grasses. The nest site was 98 m from the water's edge. The tortoise began digging the nest chamber. Digging the vertical shaft was a simple process, with the tortoise using the rear feet alternately to scoop the soil out and place the material to one side of the hole. Construction of the egg chamber was at right angles to the vertical shaft and proved more difficult and lengthy. No voiding of cloacal fluid was observed during the nesting.

1126 h Nest site completed.

1127 h Tortoise began to lay eggs. Each egg positioned in the egg chamber using each hind foot alternatively. Ten eggs were laid.

1130 h Egg-laying completed, the tortoise began to refill nest chamber by scooping soil from edge and again using the two hind feet. Once the vertical shaft had been filled, it began to compact the soil by raising itself on three legs and then letting the body fall onto the soil. This procedure appeared to be critical, as the tortoise spent several minutes repeating the process.

1140 h Refilling and compaction completed, the tortoise rested for several minutes. After the rest period it replaced vegetation over the nest site, using the hind feet. Once this procedure had been completed, the nest site was almost unrecognisable.

1145 h The tortoise returned to the lake.

Total time taken to travel to the nest site, dig egg chamber, lay eggs, refill and compact soil and return to the lake, was 1 h and 50 mins. Nesting varied considerably with climatic and soil conditions. Mean temperatures on day of nesting—spring 22.3°C (20.6°C to 24°C) and summer 28°C (25.9°C to 32.1°C).

Ascent to nesting site.—Once the females were some distance from the water's edge they were not easily disturbed and continued in the general direction of the nesting site. Whenever females were handled they would void copious amounts of fluid and return to the lake without nesting. The females did not deviate greatly from the direction in which they were travelling to the nest site. Only during the latter stages of the ascent did the female deviate to look for a suitable nest site. All females took advantage of any thick cover, presumably to avoid attacks by birds.

Distance to nest site.—Distance to nest site varied considerably between the spring and summer nesting periods (Table 3). Moll and Legler (1971) state that distances travelled from water by females of *Pseudemys scripta* are also variable. The greatest distance to a nest site was 105 m which was recorded in the spring nesting period, and the shortest distance to a nest site was 20 m which was recorded in the summer nesting period.

Table 3

Differences in distances to nest site between the spring and summer nesting periods

	Sept.-Nov.	Dec.-Jan
Mean distance to nest sites in metres (No. of nests)*	86·56 ± 10·00 (27)	25·38 ± 2·41 (80)

* p << 0·001, Student's "t" test.

Nest site.—Female tortoises appeared to have no preference for a nest site and generally chose one that was open and free from thick vegetation (Fig. 6).

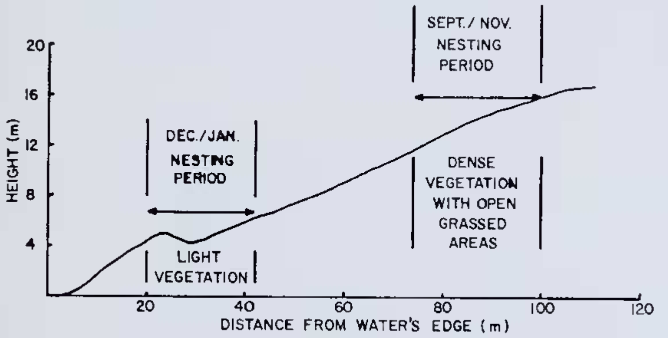

Figure 6.—A typical profile showing distances to nest sites for the two nesting periods.

Neotropical sliders also tend to nest in relatively open areas (Moll and Legler 1971). Females nesting in the summer period generally nested in heavier soils compared with the sandy soils used during the spring nesting period.

Clutch size, egg size and weight

The largest clutch (12 eggs) was recorded in the spring nesting period of 1975, and the smallest clutch (3 eggs) was recorded in the summer nesting period of 1975/1976. Egg size and weight vary within the clutch and between individuals (Tables 4 and 6).

Table 4

Differences in clutch sizes between the two nesting periods

	Sept.-Nov.	Dec.-Jan.
Mean clutch size (No. of nests)*	8·20 ± 1·22 (15)	4·00 ± 0·21 (10)

* p << 0·001, Student's "t" test.

Table 5

Mean temperature (°C) of air and nests between egg-laying and hatching taken over a period of 30 weeks

	Air temperature	Nest temperature	Significance (*)
Minimum	14·85 ± 0·67	20·39 ± 0·74	P < ·001
Maximum	28·18 ± 0·84	27·26 ± 1·00	NS
Difference	13·56 ± 0·44	6·87 ± 0·44	P < ·001

* Student's "t" test for paired samples.
NS—No significant difference.

Eggs taken from the two nesting periods of 1974/1975 and 1975/1976 show very little variation in the time of incubation. In 1974/1975, 216 to 222 days were recorded to hatching, and in 1975/1976, the period was 210 to 220 days. The average temperature in the egg chamber ranged from a minimum of 14°C. to a maximum of 29.8°C. There was a significant difference between the average minimum temperature of the nest and air temperatures (Table 5).

Discussion

The dark and opaque nature of the swamp water has unfortunately precluded any direct observation of *C. oblonga* copulating in the water. Burbidge (1967) states that *C. oblonga* were observed copulating in captivity, and that the copulatory ritual was similar to that of *Pseudemydura umbrina* and that copulation takes place in the water with the male mounting the female from the rear, as does *Pseudemys scripta* (Moll and Legler 1971). In contrast to *Chelonia mydas* (the green sea turtle) studied by Hendrickson (1958) in Sarawak, both female and male *Chelodina oblonga* leave the water and can be found on land, although the percentage of males is well below that of the females. The males do not appear to move during the peak nesting periods (Table 2).

Brattstrom (1965) reports that *Chelonia* are active over a much wider range of body temperatures

Table 6

Animal weights, mean egg size and clutch size of live animals

Animal No.	Animal weight before egg laying (g)	Carapace width (mm)	Carapace length (mm)	Egg weight (g)			Egg length (mm)			Egg width (mm)			Clutch size
				Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	
7372	1 440	224·2	134·2	11·7	11·3	11·5	36·6	35·0	35·7	23·2	22·5	22·9	8
7369	1 250	224·0	127·8	12·0	10·9	11·4	36·7	35·2	32·8	23·4	22·9	23·2	12
7375	1 170	212·8	125·4	10·9	9·9	10·4	33·8	32·2	33·1	23·5	22·6	23·0	10
7378	670	113·0	113·0	6·8	5·8	6·3	31·3	30·0	30·8	18·3	18·0	18·1	6

than terrestrial lizards. Burbidge (1967) cites Lucas (1963) in stating that *Chelodina oblonga* has a preferred temperature of between 16°C and 28°C and that from incidental observations *C. oblonga* is active within the range 13°C to 28°C. During this study the body temperature ranged from 18°C to 31°C (Fig. 3). Tolerance of air temperatures above 25°C is minimal as the animals can only survive a few hours due to desiccation.

Migrations have been reported in a number of species of turtles while nesting, such as *Chelonia mydas* and *Lepidochelys kempi* (Carr 1967), *Batagur baska* (Loch 1950), *Podocnemis expansa* (Roze 1964). Moll and Ledler (1971) state that migratory behaviour has evolved where suitable nesting sites are scarce and where feed is inadequate. Migration could be an important factor for the survival of the species.

During this study no females that were marked during the spring nesting were recaptured during the summer nesting. Professor J. M. Legler (University of Utah) has examined specimens of *C. oblonga* ovaries. Results of his investigations indicate that double nesting could occur (Legler, pers. comm. 1976). Carr (1952) suggests that the Chelonidae and Dermochelyidae do have multiple clutches.

It is suggested that females close to shore prior to nesting are (a) sensing climatic changes, i.e. a rain-bearing depression and/or a falling barometric pressure, (b) absorbing cloacal fluid prior to nesting and (c) absorbing body heat in the shallower warmer water.

Although there is a seasonal difference between the nesting behaviour of *C. longicollis* as described by Vestjens (1969), there appears to be no great difference between the two species in the excavation of the nest site, except for size. The nest size of *Pseudemys scripta* as described by Moll and Legler (1971) is similar in size to that of *C. oblonga.* The egg chamber of *C. longicollis* is smaller than that of *C. oblonga.*

Burbidge (1967) states that *C. oblonga, C. steindachneri* and probably all other Chelidae, possess a pair of bladders opening laterally into the cloaca in addition to the urinary bladder which opens ventrally. Goode and Russell (1968) state that *Chelodina longicollis* and *C. expansa* void copious amounts of cloacal fluid during the excavation of the nest site. *C. expansa* puddles its eggs in the mud produced by the excretion of the cloacal fluid. During this study it was impossible to determine when the cloacal fluid was voided during egg laying as the tail is held tight and close to the body while excavating the egg chamber. Cloacal fluid analysed by Burbidge (1967) shows that it is the same constituency as that of the lake water from which the tortoise is collected.

Some difficulty was experienced in locating females that were nesting, but it is evident from the few samples obtained that larger females lay larger and heavier eggs than smaller females (Table 6). The average clutch size for the summer nesting period was significantly lower than that of the spring nesting period (Table 5). Due possibly to the intense heat during the summer nesting period females moved a much shorter distance than the females moving to nest during the spring nesting period. (Table 3).

Incubation times during this study varied from 210 days to 222 days, compared with 138 days for *C. longicollis,* 342 days for *C. expansa,* and 75 days for *Emydura macquari.* (Goode and Russell 1968). Eggs laid in the spring nesting period hatch in 210 to 222 days and remain underground in an embryonic position until they emerge. Eggs laid in the summer nesting period take as long to incubate but remain in the nest for a shorter period, and young emerging at the same time (mid-August) as hatchlings from the spring nesting period. Reports by amateur observers tend to support the findings of this study that the young emerge about mid-August, with slight variations depending on seasonal conditions.

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